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Radiomorphometric Localization of Mental Foramen and Mandibular Canal using Cone Beam Computed Tomography as an Aid to Gender Determination: A Retrospective Study

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ABSTRACT

AIM: The present study aimed at evaluating the role of mental foramen and mandibular canal in gender determination using CBCT.

METHODOLOGY: A total number of 73 volumes of CBCT of the mandible was evaluated. Four measurements were used to assess the bucco-lingual and supero-inferior location of mandibular canal and the supero-inferior location of mental foramen was determined using two measurements on both right and left sides of the mandible. Inter and intra-observer variability was analyzed with help of t-test.

RESULTS: Good intra-observer and inter-observer agreement was noted with regard to all the six measurements. The mean of all the measurements of mental nerve foramen and mandibular canal was found to be higher in males than females, however, significant difference was noted with regard to Superior Mental foramen (SMeF) and Superior Inferior Alveolar Canal (SMC) ($p=0.037$, $p<0.001$ respectively) on the right side and SIAC and Inferior Inferior Alveolar Canal (IIAC), ($p=0.015$, $p=0.046$ respectively) on the left side.

CONCLUSION: The results of the present study suggest that SMeF, SIAC and IIAC may be used for gender determination. Further, either side of mandible can be used for this purpose. CBCT was found to be a useful modality in this study for sexual dimorphism.

KEYWORDS: CBCT, Gender determination, Mandibular canal, Mental foramen, Sexual dimorphism.

INTRODUCTION

Identification of an individual is important and the reasons for attempting identification are manifold. It plays a significant role in homicides, loss of lives owing to natural calamities, wars, terrorist attacks, major road traffic accidents etc. Further identification can aid tremendously in the process of grief resolution by family and friends. The personal identification of humans can be performed by analyses of fingerprints, DNA and osseous structures. However, when soft tissue becomes putrid or severely burnt, the fingerprint identification and DNA analysis cannot be carried out. Identity of the remains could be determined by examining the osseous structures.[1]

Gender determination is an important component of personal identification. Although osseous structures of the skull like foramen magnum[2], frontal and maxillary sinuses[3], have been used in gender determination, the preservation of these structures after the death of an individual is less likely. The mandible is one of the most indestructible parts of the body and upon exposure to physical injury and putrefaction, it outlasts other tissues. The preservation of mandible in ancient human relics for centuries attests to this fact. The foramina of the mandible and mandibular canal have a relatively constant location in the mandible throughout the life of an individual. The position of the mental foramen remains relatively unchanged in spite of the resorption of the alveolar bone as the distance between the mental foramen and the inferior border of the mandible remains unaltered. Hence, these mandibular characteristics are useful for determining gender.[4]

These can be examined by direct visualization on cadavers or by radiological imaging. Two dimensional (2D) imaging techniques have been used for the assessment of these structures, but they have a number of limitations such as magnification, distortion, superimposition and misrepresentation of structures.[5] Computed tomography is a three dimensional imaging modality that has overcome the disadvantages of conventional imaging. It has been demonstrated to be effective in assessing the size and location of the structures like mental foramen and mandibular canal in forensic and anthropologic studies. CBCT is a more recently introduced imaging modality that offers undistorted three dimensional information of the maxillofacial anatomy with significantly lower effective radiation dose and higher spatial resolution than CT6. However, very few studies have been conducted in the forensic scenario

using CBCT for evaluation of mental foramen and mandibular canal.

With the above background, this study was aimed at the assessment of the location of mental foramen and mandibular canal in CBCT images to evaluate their role in gender determination.

MATERIALS AND METHODS

A total of 73 CBCT volumes of the premolar/molar region of the mandible were retrieved from archival records. Radiographs with evidence of fractures, impacted teeth, cysts/ tumors /osteomyelitis in the premolar and molar region of the mandible were excluded from the study. Images with developmental abnormalities of the mandible like aplasia, bone and joint disorders were also excluded. Further, errors and artifacts obscuring visibility of structures in the mandible and images with associated crestal bone resorption for more than middle 1/3rd of the root in the images were also excluded. A Kodak 9300C CBCT machine with the following exposure parameters was used. A tube voltage of 90 Kvp, tube current of 5 mA, exposure time of 14 seconds, cylindrical field of view (FOV) measuring 14x17 mm with a voxel size of 90 microns was used to obtain these images. The sagittal, coronal and axial sections of image were reconstructed from the projection data. The location of the inferior alveolar canal and mental foramen were assessed on both the right and left sides of the mandible under standard viewing conditions. For assessment of the location, the measurements and the abbreviations suggested by Gamba et al. have been used in the present study.[7] For the inferior alveolar canal, the following four measurements were made in the coronal sections:

- The distance from the superior border of the inferior alveolar canal to the crest of the alveolar ridge of the mandible: superior inferior alveolar canal (SIAC).
- The distance from the inferior border of the inferior alveolar canal to the lower border of the alveolar ridge : inferior inferior alveolar canal(IIAC).
- The distance from the lingual border of the inferior alveolar canal to the lingual aspect of the alveolar ridge : lingual inferior alveolar canal(LIAC).
- The distance from the buccal border of the inferior alveolar canal to the buccal aspect of the mandibular alveolar ridge: buccal inferior alveolar canal (BIAC).
- The location of the mental foramen was also assessed in the coronal slice of the CBCT using two measurements.
- The distance from superior border of the mental foramen to the crest of the alveolar ridge: superior mental foramen (SMeF).
- The distance from the inferior border of the mental foramen to the base of the mandible: inferior mental foramen (IMeF).

Two examiners independently recorded the measurements of the mandibular canal and mental foramen. The first observer measured the various parameters twice with an interval of 15 days. Inter and intra-observer variability was statistically assessed with the help of t-test. The second observation of the first observer was used for assessment of inter-observer variability. All the 6 morphometric measurements obtained were compared between the genders and student t-test was used to assess the difference between them. The measurements were also compared between the right and left sides using the t-test.

RESULTS

The CBCT images of 73 subjects were included in the study group. Of the 73 subjects, 41 were males and 32 were females. The age of subjects ranged from 17 to 69. Good intra-observer and inter-observer agreement was noted with regard to all the 6 measurements of mental foramen and mandibular canal. Hence, the measurements obtained in the second observation of the first observer were used for further analysis. The mean of all the 6 measurements of the mental foramen and mandibular canal was found to be higher in males than females. This difference was evident on both the sides of the mandible. Statistical significant difference was noted with regard to SMeF and SIAC ($p= 0.037$, $p<0.001$ respectively) on the right side (Table 1). On the left side of mandible, significant difference was noted with regard to SIAC and IIAC ($p= 0.015$, $p= 0.046$ respectively), (Table 2).

In the present study, the mean measurements of the mental foramen and mandibular canal made on the right side of mandible did not differ significantly from the left side irrespective of the gender.

DISCUSSION

The field of forensic anthropology is of great

significance in discerning an individual's gender and age. Various osseous structures such as human pelvis[8], skull foramina[2] and bones have been used in the gender identification. The mandible is the most durable bone in the human body. It exists in an unchanged state longer than any other bone because of the presence of a dense layer of compact bone.[9]

The mean measurements with regard to mental nerve foramen and mandibular canal in the present study were higher in males as compared to females. This is in accordance with a study conducted in Baghdad.[9] Bone growth in the adult phase can be controlled by multiple factors. Sex hormones, such as oestrogen and progesterone can influence the speed of bone growth, contributing to the development of differences in the craniofacial morphology between the genders. The speed of growth of the bone is higher in males resulting in craniofacial dimensions that are from 5 to 9 % greater when compared with women. Furthermore, the muscular tension is considered an inductive factor of bone formation, and in the mandible, the contraction of the elevator muscles during masticatory movements exerts tension in the ramus. In general, men have stronger masticatory muscles than women.[9]

In the present study, the mean SMeF was significantly higher in males, whereas significant difference was not noted with regard to the IMeF. This is in contrast to a Brazilian study, wherein the mean IMeF significantly differed among the genders. Whereas studies conducted in US[10], Taiwan11, Thailand12 and Lebanese population[13] found that both SMeF and IMeF were significantly higher in males. This variation amongst the populations could be due to difference in foods, habits and customs resulting in distinct anatomic features.[7] Further, differences in the imaging modalities utilized in studies may also contribute to this variation as most of the previous studies have been conducted on cadavers and panoramic images.

The results of the present study with regard to the mental foramen have been found to differ from three other Indian studies, two of which were conducted in North India[4,14] and one in South India15 in which both SMeF and IMeF were found to be significantly higher in males than females. This can be attributed to the diverse ethnic population of the country.[9]

The characteristics of the mandibular canal such as the positioning and its curvature in males can differ from females. In the present study, the IIAC was found to be statistically significant among the gender which is in accordance with a Brazilian study[7] and an Indian study.[16] Further, SIAC was also significant in the present study which is in accordance with a study conducted in the US.[10] Other parameters such as BIAC and LIAC were not significant in the present study which is in accordance with the above mentioned Brazilian[7] and Indian studies.[14,16]

In the present study, no significant difference was noted with respect to the measurements of mental foramen and mandibular canal on the right and left side of the mandible. Similar findings have been reported in other studies done in the previously mentioned North Indian[14] and Lebanese population.[13]

CONCLUSION

In the present study, of all the parameters assessed, it was found that SMeF, SIAC and IIAC can be used for gender determination. Also, the results of the present study suggest that either side of the mandible can be used for gender estimation. CBCT was found to be a useful modality in this study for gender determination.

REFERENCES

1. Tang et al. Assessing forensic applications of the frontal sinus in a Chinese Han population. Forensic Sci Int 2009; 183:104.
2. Ilguy et al. Measurements of foramen magnum and mandible in relation to sex using CBCT. J. Forensic Sci 2014, 59 (3); 601-5.
3. Nigel et al. Skeletal identification using the frontal sinus region: a retrospective study of 39 cases. Journal of forensic sciences 2002; 47 (2): 318-23.
4. Thakur et al. Gender Determination by Mental Foramen and Height of the Body of the Mandible in Dentulous Patients-A Radiographic Study J Indian Acad Forensic Med. 2014, 36;(1):13-8.
5. Krimmel et al. Mandibular fracture after third molar removal. J Oral Maxillofac Surg. 2000;58: 1110-2.
6. Patel S. New dimensions in endodontic imaging: Part 2 Cone beam computed tomography. Int Endod J. 2009; 42:463–475.
7. Gamba et al. Analysis of sexual dimorphism by locating the mandibular canal in images of cone-

beam computed tomography, J Forensic Radiol Imag 2014, 2; 72–76
8. Stanojevich V. The Role of a Forensic Anthropologist in a Death Investigation. J Forensic Res 2012, 3:154.
9. Rashid et al. Sex determination using linear measurements related to the mental and mandibular foramina vertical positions on digital panoramic images. J Bagh Col Dentistry. 2011; 23 :59-64
10. Angel et al. Cone-beam Computed Tomography for analysing variations in Inferior Alveolar Canal location in adults in relation to age and sex. J Forensic Sci 2011, 56 (1); 216-219
11. Lo LJ, Wong FH, Chen YR. The position of the inferior alveolar nerve at the mandibular angle: an anatomic consideration for aesthetic mandibular angle reduction, Ann. Plast. Surg., 2004; 53,50–5.
12. Agthong S, Huanmanop T, Chentanez V. Anatomical variations of the supraorbital, infraorbital, and mental foramina related to gender and side, J. Oral Maxillofac. Surg. 2005; 63, 800–4.
13. Levine et al. Inferior alveolar nerve canal position: a clinical and radioc study, J. Oral Maxillofac. Surg. 2007; 470–4.
14. Chandra et al. Determination of sex by radiographic analysis of mental foramen in a North Indian population. J Forensic Denti Sci; 5(1):52-55
15. Mahima VG. Mental foramen for gender determination: A panoramic radiographic study. Medico-Legal Update 2009; 9:33
16. Bhardwaj et al. Age prediction by evaluating changes in various parameters in mandible Using Digital Panoramic Radiography, JCDR 2014, 8(10): 66-9.

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LEGENDS

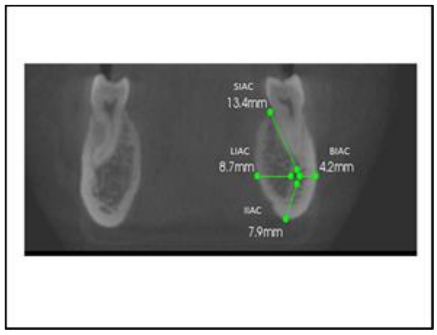

Figure 1. Measurements of the mandibular canal on the left side (SIAC= 14.5 mm) (IIAC= 7.7 mm) BIAC= 4.5 mm) (LIAC= 3.9 mm).

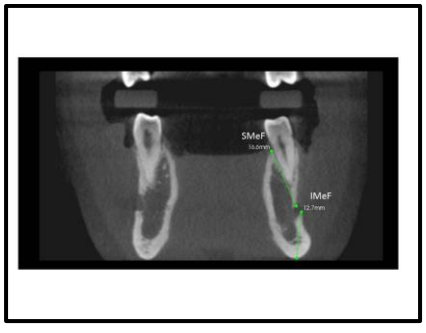

Figure 2. Measurements of the mental foramen on the left side (SMeF= 16.6 mm) (IMeF= 12.7 mm)

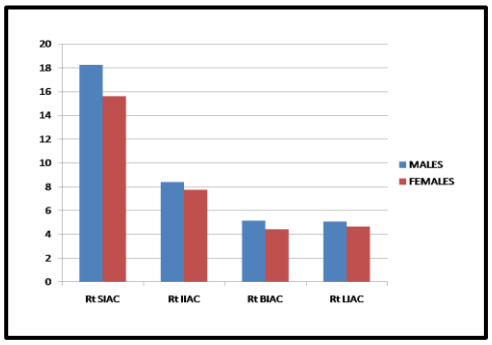

Figure 3. Comparison of gender on the right side for mandibular canal

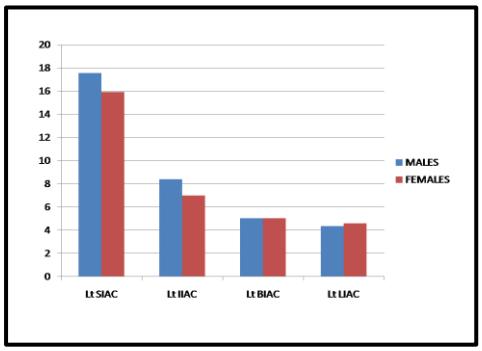

Figure 4. Comparison of gender on the left side for mandibular canal

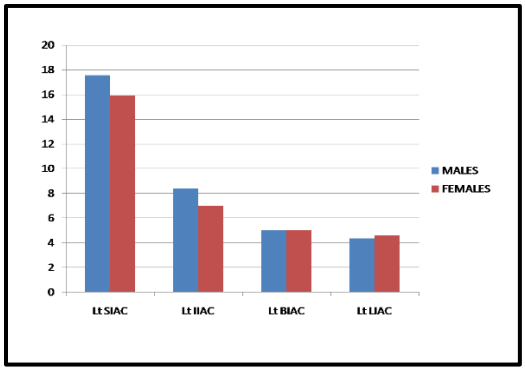

Figure 5. Comparison of gender for mental foramen on right and left sides

VARIABLE (in mm)		MALES		FEMALES		p value
		MEAN	SD	MEAN	SD	
1.	SMeF	15.233	2.009	14.270	1.664	0.037*
2.	IMeF	14.810	2.232	14.048	1.559	0.112
3.	SIAC	18.225	2.759	15.609	2.096	<0.001*
4.	IIAC	8.404	1.863	7.761	1.863	0.226
5.	BIAC	5.171	1.593	4.443	1.350	0.089
6.	LIAC	5.061	1.984	4.657	1.614	0.436

Table 1. Comparison of gender for mental foramen on right and left sides

VARIABLE (in mm)		MALES		FEMALES		p value
1.	SMeF	MEAN	SD	MEAN	SD	
		14.549	1.863	14.128	2.199	0.380
2.	IMeF	14.607	2.192	14.056	1.771	0.251
3.	SIAC	17.571	2.407	15.905	2.096	0.015*
4.	IIAC	7.939	1.516	7.000	1.678	0.046*
5.	BIAC	5.064	1.900	5.033	0.833	0.945
6.	LIAC	4.346	1.918	4.614	2.069	0.642

Table 2. Comparison of the mean measurements of the mental foramen and mandibular canal between genders on the left side